ABC Operators Webinar Series:

Safety

Our Partners:

O'BRIEN & GERE

OWS Organic Waste Systems

August 30, 2012

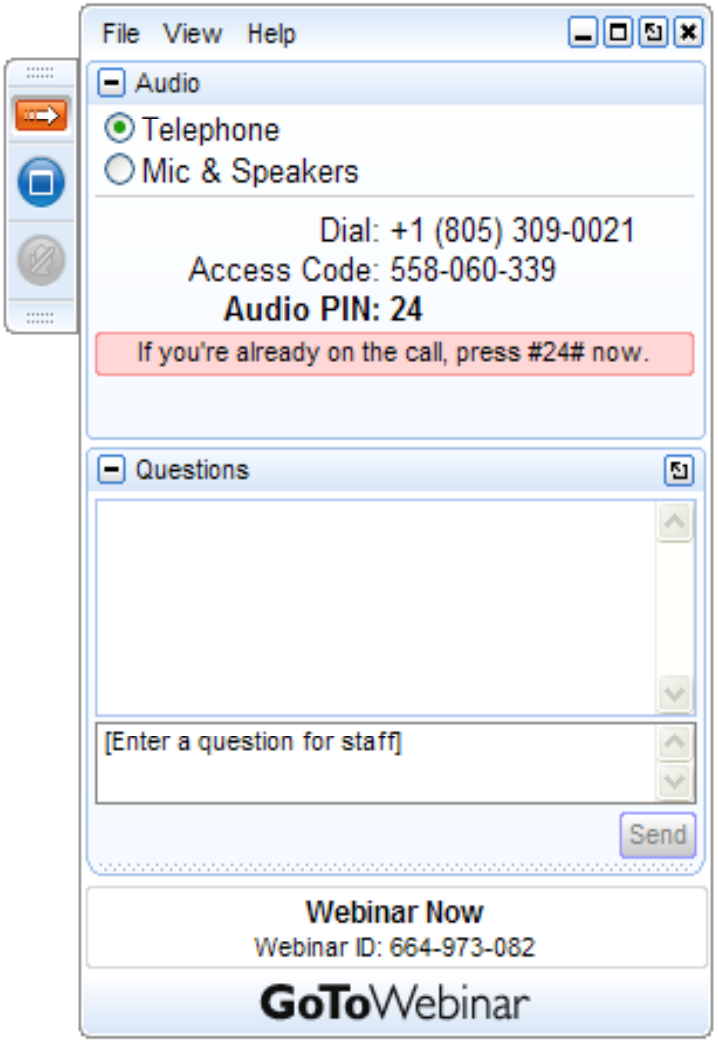
Noon – 1 p.m. ET

Quick Notes

- Two Audio Options: Streaming Audio and Dial-In.
  1. Streaming Audio/Computer Speakers (Default)
  2. Dial-In: Use the **Audio Panel** (right side of screen) to see dial-in instructions. Call-in separately from your telephone.

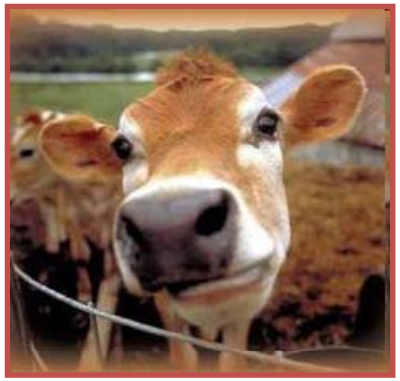
- Ask questions using the **Questions Panel** on the right side of your screen.

- The recording of the webinar and the slides will be available after the event. Registrants will be notified by email.



Promoting the use of Biogas and Anaerobic Digestion

- 160 Members from the U.S., Germany, Italy, Canada and the UK
- All Industry Sectors Represented



Key Industry Goals:

- Promote biogas markets, technologies and infrastructure
- Achieve policy parity
- Promote as a best practice for environmental stewardship and greenhouse gas reduction

Changing the Biogas Industry through:

- Legislative and Regulatory Affairs -
  - **Federal**: Biogas Tax Credit; Clean Energy Standard; NAT GAS Act; Farm Bill
  - **States**: California, Iowa, Massachusetts, Indiana, more…
- Sharing Expertise –
  - Specialized Working Groups
- Education and Outreach -
  - Briefings, presentations, and webinars for customers, policy makers, and the general public
- Large Industry Network – 150+ company members
  - Entire supply chain of production, processing and use

Join Today!

Email Josh Lieberman at jlieberman@ttcorp.com or call 202-261-1322

Speakers

Sara Martin – Project Associate, O'Brien & Gere

Norma McDonald – North American Sales Manager, Organic Waste Systems

Andy Austin – Biosystems Engineer, Scenic View Dairy, LLC

Presenter

Sara Martin – Project Associate, O'Brien & Gere

Sara has experience in the areas of wastewater design and project management. Her experience includes design-build implementation of anaerobic and aerobic wastewater treatment systems for various industries, specializing in food and beverage. Her experience also includes project development, and implementation of conceptual design and basis of design work, including treatability and pilot studies. She has worked in various new emerging markets, including waste to energy and net zero wastewater facilities.

Biogas Piping Design and Safety - An Overview

By Sara Martin, P.E.
O'Brien & Gere

O'BRIEN & GERE
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Outline

- Introduction
- What is Biogas?
- Applicable Standards and Guides
- Design Overview
- Biogas Appurtenances
- Design Considerations
- Questions

Introduction

- Presentation covers:
  - Digester Piping Safety and Design Considerations
  - Low Pressure Piping From Digester to Compression or Use-Point
  - Does not cover high pressure piping and/or interconnecting grid piping

Why is this so important?

- Personnel Safety
- Protection of Investment
- Protection of Downstream Use Points

What is biogas?

Biogas is a moist gas produced from anaerobic decomposition of organic matter;

typically 100% saturated with water vapor,

50-80% methane,

20-50% CO_2

with other impurities such as hydrogen sulfide and mercaptans.

quality of gas dependent on substrates digested and quality of resultant gas

Two major combustive components:

Methane is a colorless odorless gas, less dense than air and explosive when mixed with air in concentration of 5-15%

Hydrogen Sulfide is a colorless odorous gas (smells of rotten egg), heavier than air and very flammable

Why can't we just use codes and regulations for natural gas?

- Natural gas piping design heavily regulated, with many codes and standards in place for all aspects from design, operations, inspection, purging, etc. Can miss major design considerations and drive cost up considerably .

Why can't we just use codes and regulations for natural gas?

- Biogas is a different gas that must be handled differently for the following reasons:
  - Biogas operates at a lower pressure
  - Higher risk of oxygen entrainment
  - Higher risk of spark sources
  - 100% saturated gas which lends to other design considerations such as higher level of corrosion, condensation, freezing, fouling. etc.

- In general, biogas piping from a digester to point of use has is a higher chance of conditions that can cause an explosion or fire – namely entrainment of oxygen and spark.

Recommended Applicable Standards and Guidelines

In general, there is no “thou shall” document out there

- Aspects of the following standards and guidelines can be utilized with good common sense engineering practices.

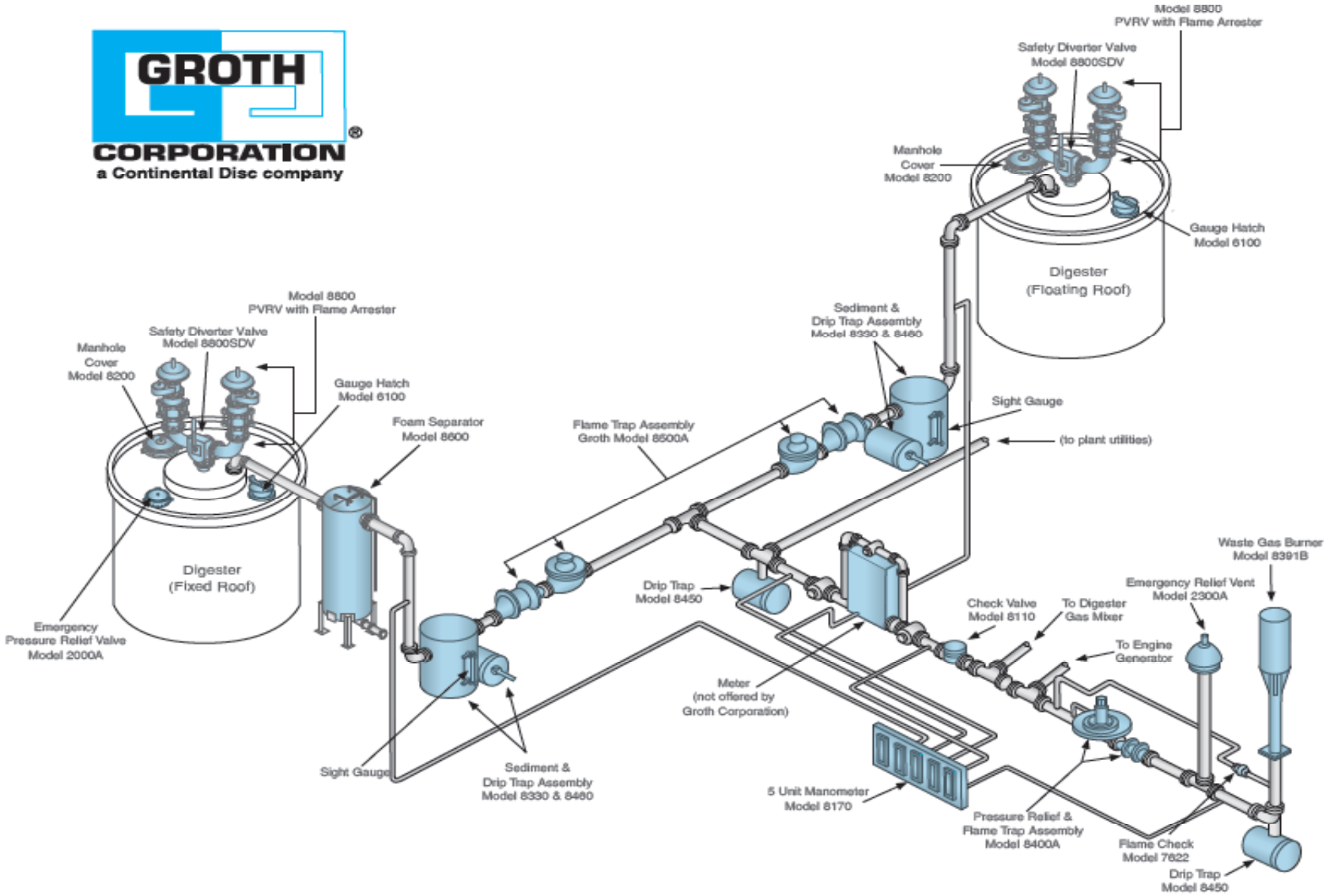
Recommended Applicable Standards and Guidelines

NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities	• Suggested Location of Digester Relative to Other Buildings and Equipment • Classification of Digester, Vents and Areas Processing Biogas
API 2000 – Venting Atmospheric and Low-Pressure Storage Tanks	• Tank venting considerations
NFPA 54 - National Fuel Gas Code	• Natural Gas Piping Design Guidelines

Recommended Applicable Standards and Guidelines

NFPA 497 – Recommended Practice for the Classification of Flammable Liquids, Gases or Vapors	• Area classification of Digester, Vents and Areas Processing Biogas
NEC 70 – National Electric Code	• Intrinsic Safety Measures
State or Local Building Code OSHA	• Need to be reviewed for additional or ancillary requirements – flare locations, etc.
Various Publications	• Water Environment Federation Manual of Practice No. 8 • Biogas Utilization Handbook, Department of Energy/Georgia Tech, 1988 • Varec, Groth, OCECO – published guides

Biogas Piping Design Appurtenances



Biogas Piping Design Considerations

- Flame/Spark Source
- Pressure Regulation
- Oxygen Entrainment
- Leaks
- Moisture
- Corrosion

Biogas Piping Design Considerations

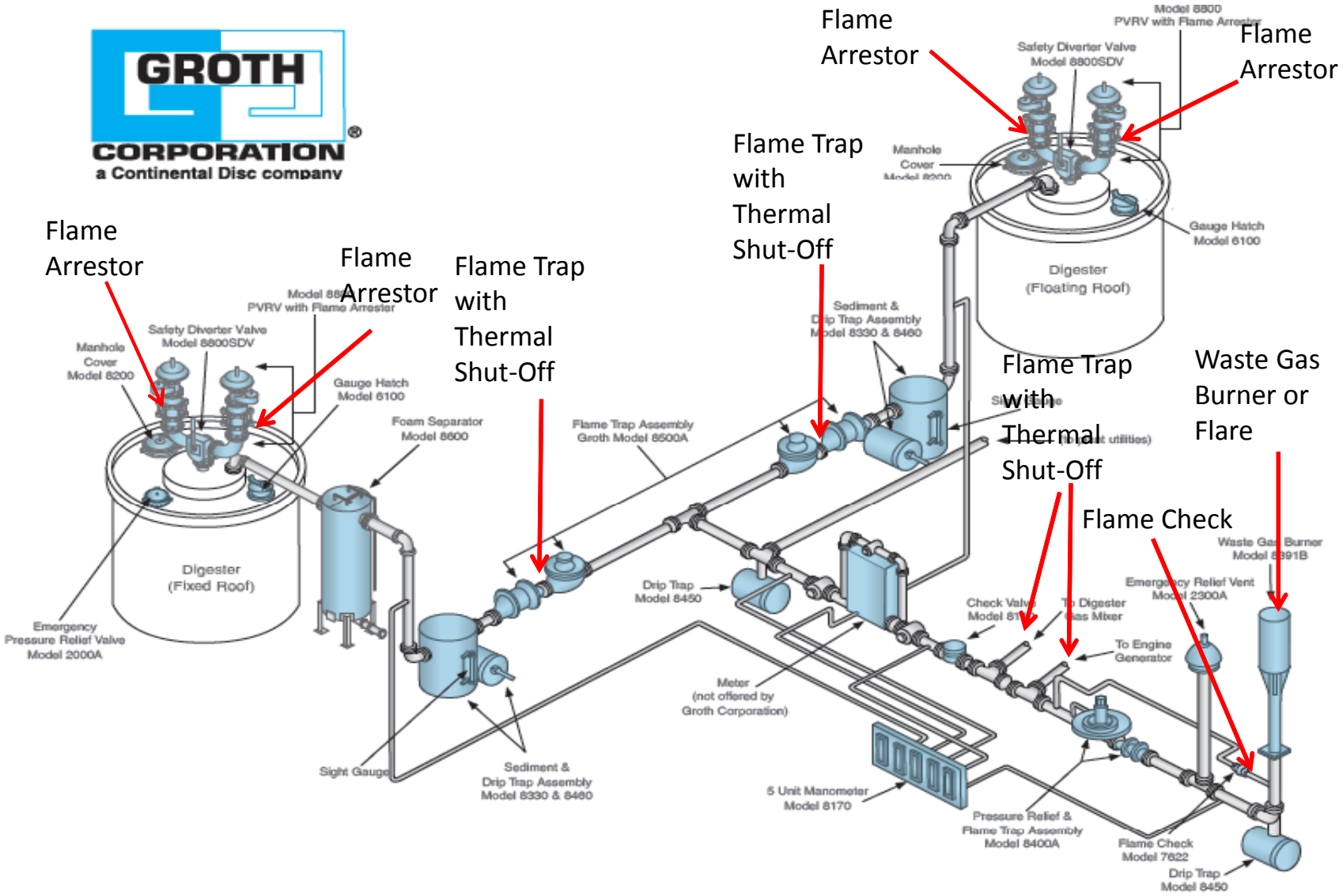
Flame or Spark Source

Biogas Piping Design Considerations

Flame or Spark Source

- **Electrical Devices**
  - Proper Classification of Areas – must be updated periodically!!!!
  - Proper seal-offs
  - Intrinsically Safe Devices and Controls rated for classification
- **Flare**
  - Reactor should always vent through flare
  - Location at least 20-30 feet away from reactor, if possible
  - Flame Arrestor and Thermal Shut-Off Valve
- **Blower, Compressor or Combustion Device**
  - Equipment Approved For Use With Biogas
  - Non-Sparking
  - Flame Arrestor and Thermal Shut-Off Valve
- **Others**
  - Static Electricity – Grounding
  - Lightning Protection
  - Flame Arrestor on Reactor Vent
  - Proper Distances of Flame to Prevent Propagation

Biogas Piping Design Appurtenances



Biogas Piping Design Considerations

Pressure Regulation

Biogas Piping Design Considerations

Pressure Regulation

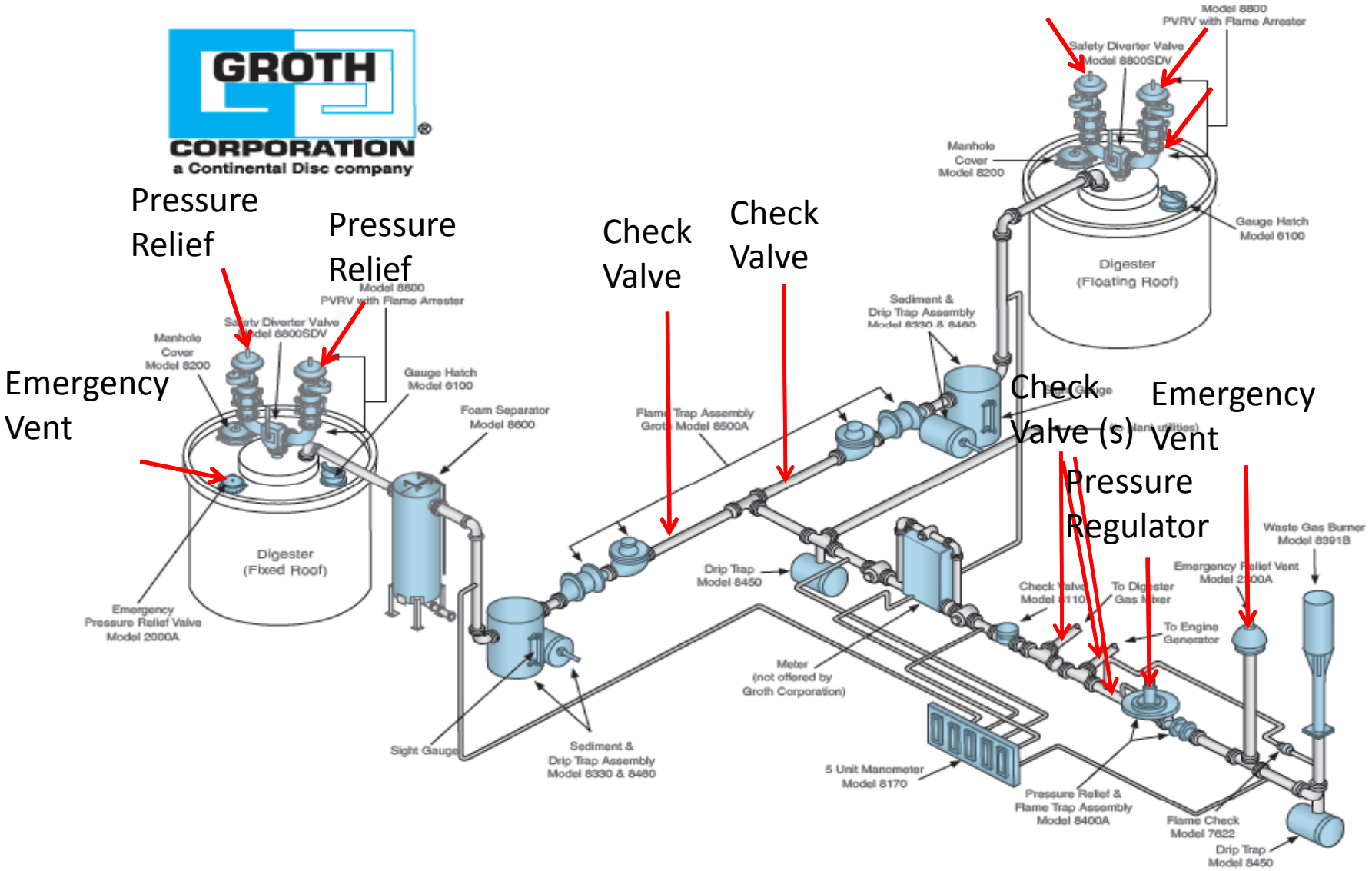
- **Undersizing Piping and Equipment**
  - Low pressure system – design pipe size accordingly
  - Verify maximum biogas production, tank inbreathing and outbreathing, vacuum pull from blower or compression device
  - consider worst case for vents and relief devices – add safety factor for corrosion and fouling
- **Emergency Venting**
  - Always include as fail safe measure
- **Pressure Balance**
  - Need check valves to prevent pressure differences between connected reactors
  - Check Valves at pipe splits to prevent backflow due to pressure differences – split to blower, flare, gas mixing, etc.

Biogas Piping Design Considerations

Pressure Regulation

- **Freezing Vents**
  - Jacket and heat trace pressure relief devices
- **Fouling of Vents**
  - Maintenance Procedures to clean vents - biogrowth
  - Consider dual vents with isolation
- **Foaming**
  - Collection or suppression needed to prevent plugging of vent pipe

Biogas Piping Design Appurtenances



Biogas Piping Design Considerations

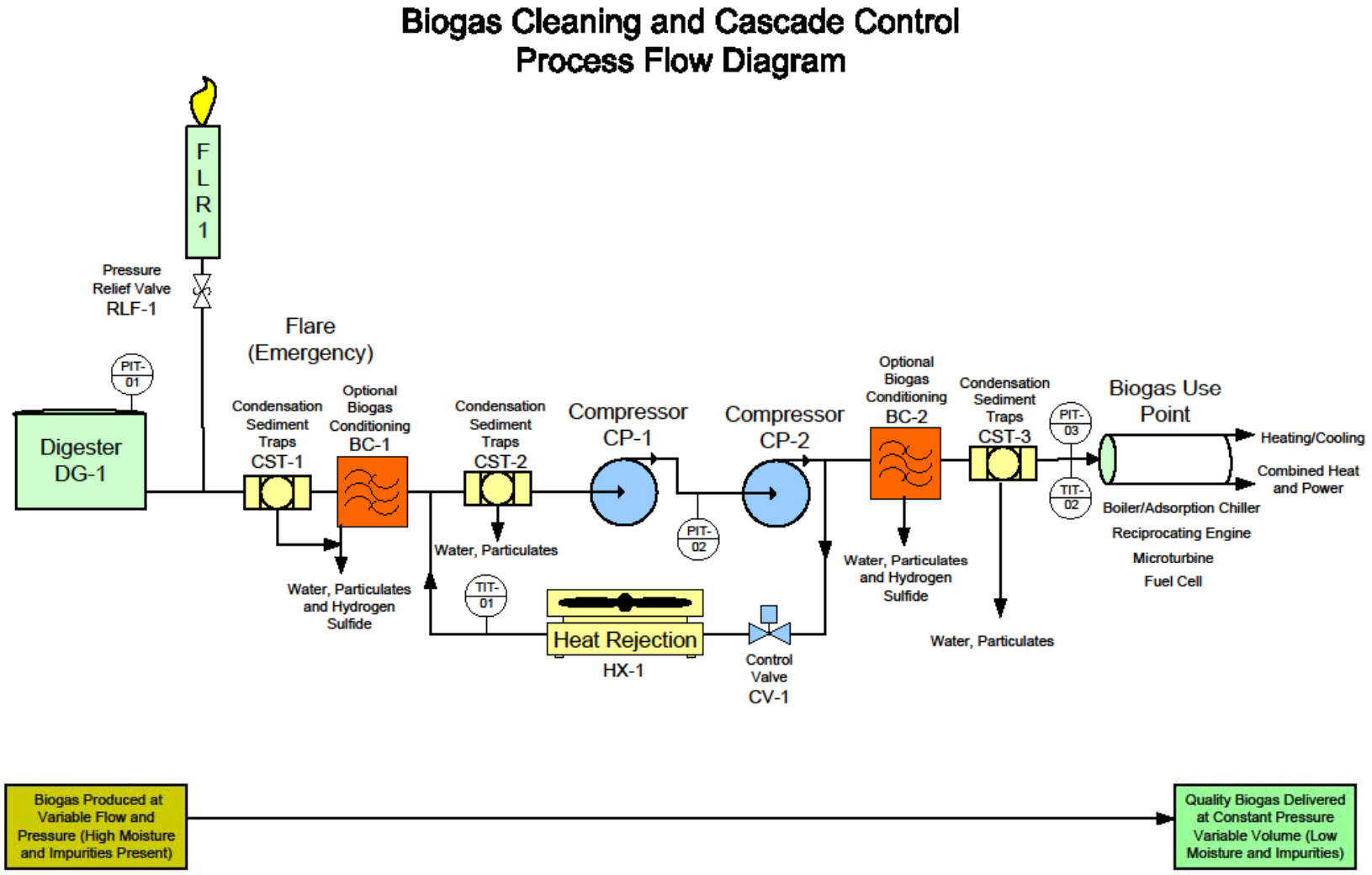
Oxygen Entrainment

Biogas Piping Design Considerations

Oxygen Entrainment

- Prevent 5-15% mixture of oxygen to methane
- If possible allow tank pressure be mode of conveyance to use point - do not undersize biogas piping where will need a blower to convey to flare or use point
- Blower or Compression Device must be designed to operate based on reactor pressure available
- Pressure control must be reasonable for blower to operate
- Utilize gas storage or buffer as needed.

Biogas Utilization – Overview of End-Use Technologies



Biogas Piping Design Considerations

Leaks

Biogas Piping Design Considerations

Leaks

- **Tank Vents, Maintenance Hatches**
  - Pressure/Vacuum Conservation Vent on Reactor Need to be Sealed Tight with Lockable Mechanisms
  - Extend Maintenance or Sampling Hatch Below Water Surface
- **Piping Flanges and Drains**
  - Gaskets – Compatibility
  - Drains – Need a hydraulic trap or drip trap
- **Pressure Regulating Valve**
  - Sized properly to only relieve as needed to flare – avoid “chatter”

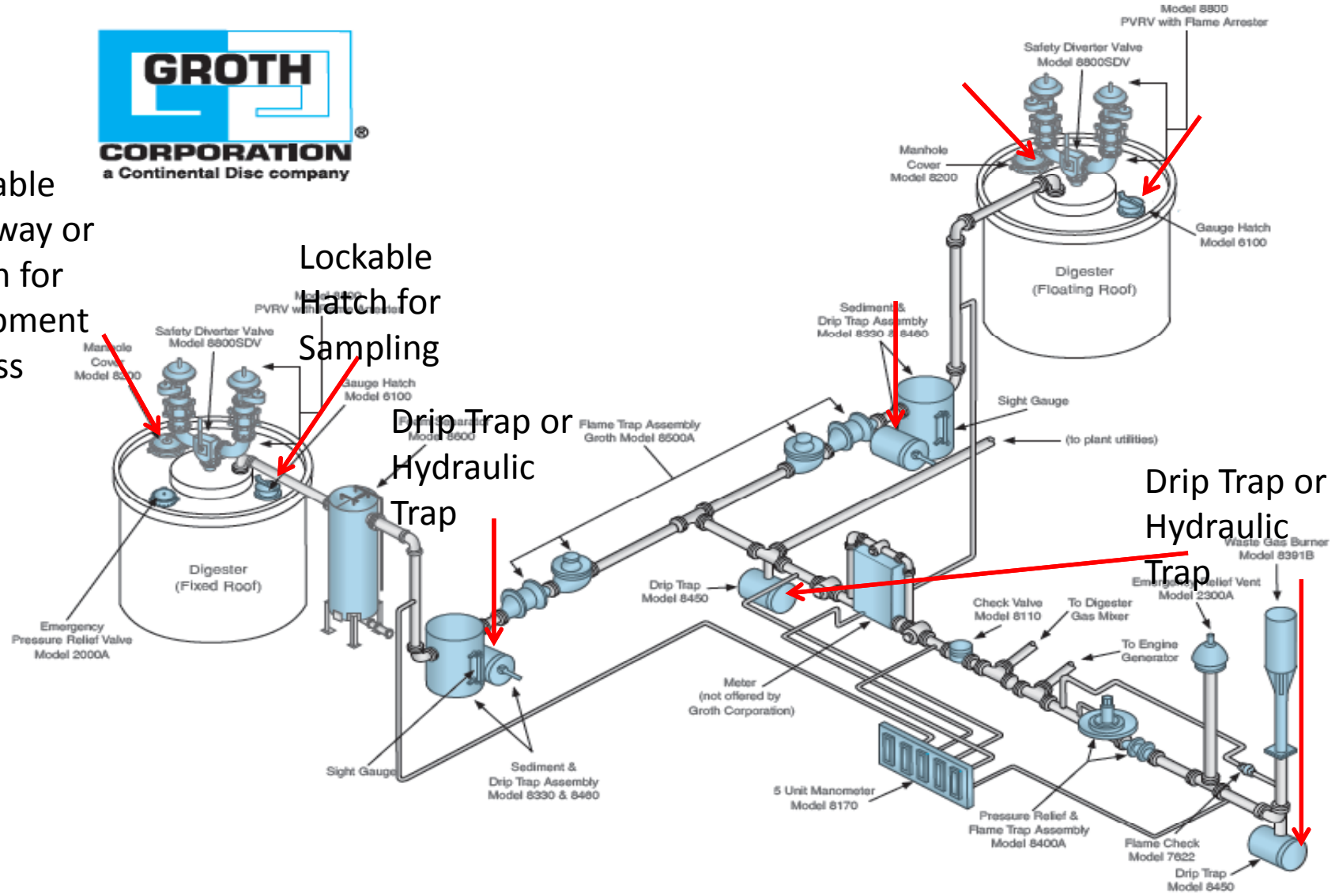
Biogas Piping Design Appurtenances

Lockable Manway or Hatch for Equipment Access

Lockable Hatch for Sampling

Drip Trap or Hydraulic Trap

Drip Trap or Hydraulic Trap



Biogas Piping Design Considerations

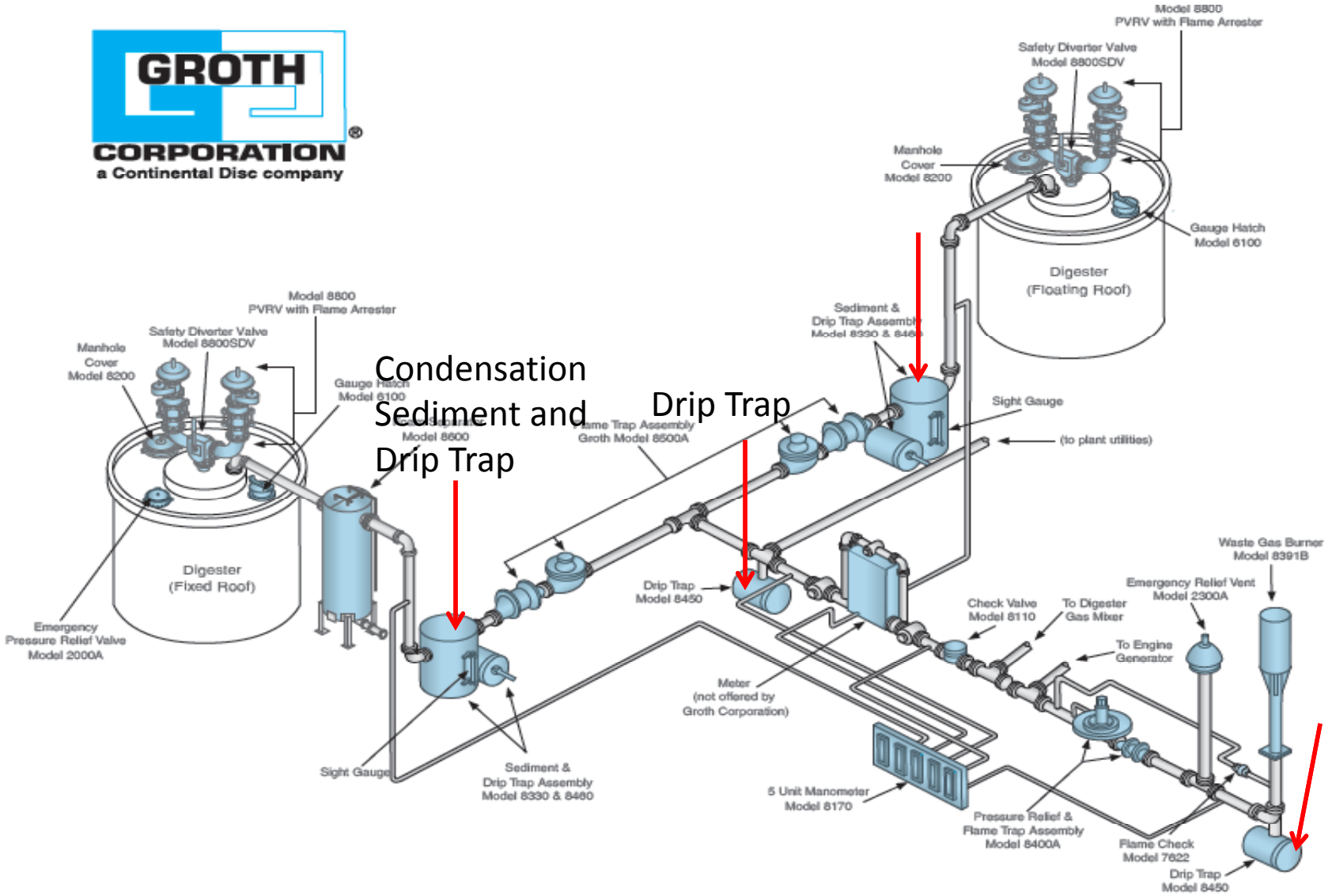
Moisture

Biogas Piping Design Considerations

Moisture

- **Condensation Collection and Drainage**
  - Condensation/Sediment Traps Immediately on Drop Leg From reactor
  - Condensation Collection at Low Points - do not use pipe for collection
  - Make sure to drain low points manually or automatically
- **Pipe Slope**
  - At least 2% recommended
  - Slope back to feasible collection points
  - For long runs provide collection at least every 250 feet
- **Freezing**
  - Heat trace and insulate all piping
  - Heat trace and jacket appurtenances
  - Especially low points and drains

Biogas Piping Design Appurtenances



Biogas Piping Design Considerations

Corrosion

Biogas Piping Design Considerations

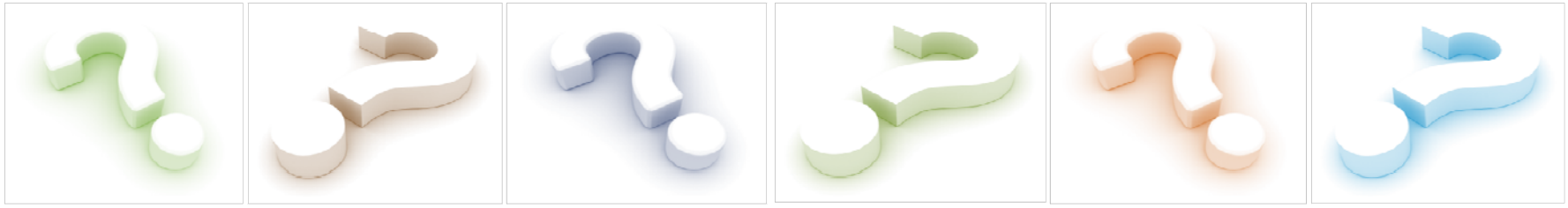
Corrosion

- **Materials of Construction**
  - Can reduce effective diameter of pipes and appurtenances
  - Pinhole leaks
  - Can degrade appurtenances
  - Need to clean or replace corroded materials
  - Consider life cycle costs
- **Sulfide Removal**
- Consider low tech solution within pipeline to knock out initial concentrations

QUESTIONS?

Sara E. Martin, O'Brien & Gere

sara.martin@obg.com



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Presenter

Norma McDonald – North American Sales Manager, Organic Waste Systems

Norma McDonald has over twenty five years of international experience in a variety of positions relating to fermentation and biochemicals. Her responsibilities have included: Establishing and managing a company focused on anaerobic digestion of organic residuals; purchasing enzymes and specialty chemicals; managing research, development and commercialization of new chemicals and bioplastics; sales and marketing of laboratory services for compostability and biodegradability

OPERATIONAL SAFETY MEASURES FOR BIOGAS PLANTS

Norma McDonald, OWS, Inc.

THE BASICS

Operational safety begins with putting the digester into service and continues throughout the operational life of the system.

- The startup plan must be developed jointly by the system provider and the plant operator, and be specific to the site – there are no generic plans! Starting up or re-starting a system entails the greatest risk.
- The operation and maintenance of the biogas system must be performed only by reliable persons familiar with the work – decide early if off-site personnel will be used for maintenance and train them!
- Detecting unsafe conditions depends on knowing what is a safe condition and being able to detect changes – make sure monitors and gauges are maintained and records are kept!

OPERATIONAL SAFETY REQUIRES DAILY ATTENTION

- Train (and certify if available) at least two operators for the biogas system who are there on a daily basis.

- Operating instructions must always be placed permanently in the operating room in an easy to read and follow manner.

-Keep an operational log must be kept with daily measurements, control, and maintenance work, as well as malfunctions. Figure out either a carrot or stick to make sure it gets done.

- Make sure that malfunctions or abnormal situations are addressed in the log and determine if procedural or equipment changes are needed

Biogas Plant Parameter	Last test / Next test	Deficiency detected?		Deficiency immediately remediated?		Test results, notes, comments Possible entry into operating log	Name of test organization qualified person	Notification acknowledged by management
		Yes	No	Yes	No			
1. CHP unit complete visual inspection/ functional test								
2. Substrate pumps, visual inspection/ functional test								
3. Gas storage Visual in section/ functional test								
4. Gas compressor Substrate pumps, visual inspection/ functional test								
5. Emergency flare, visual inspection/ functional test								
6. Agitators, visual inspection/ functional test								
7. Solids feeder Substrate pumps, visual inspection/ functional test								

SAFETY DURING MALFUNCTIONS

If the genset or other biogas-using equipment malfunctions, the gas flow needs to be shut out, and production of biogas must be reduced.

Suitable measures for reducing the gas production are, e.g.:

- stop the supply of substrate
- stop the supply of heat to the digester

SAFETY DURING MALFUNCTIONS

Gas storage room

- shut off gas supply
- empty the gas storage
- avoid ignition sources
- entry for authorized personnel only after and with sufficient ventilation, while being accompanied by a second person (who remains in the vicinity of the opening to the storage) and being secured, e.g., with a rescue apparatus and lifebelt (harness)

Hot running machines and parts, substrate or hot oils

- avoid contact with hot surfaces, fluids, gases, ...
- caution with hot water discharge: potential scalding hazard!

SAFETY DURING MALFUNCTIONS

Machine room and combined heat and power unit

- shut off gas supply outside of the machine room
- activate the emergency off switch outside of the machine room
- if necessary, force ventilation (e.g., in the case of gas odor)
- if there is a gas odor, avoid ignition sources, e.g., non EX-protected light sources, open flame, or formation of sparks.

Danger of explosion!

- if the gas alarm comes from a gas-warning device, separate operating instructions must be created and followed

SAFETY DURING MALFUNCTIONS

Electrical system

- work on the electrical systems must be performed only by a skilled electrician

Liquid manure lines and scraper

- Get rid of blockages immediately
- in the case of malfunctions in the pump system: shut off all scrapers after the pumps are stopped

Pumps and mixer

- switch off the electrical supply, and secure the switch against unintentional actuation

Operating Instructions for
Initial Startup/Restart of a Biogas System

The initial startup of a biogas system is a special operating state, which requires special actions. Explosion zones must be considered in detail.

1. During the initial startup, a hazardous, potentially explosive atmosphere can occur in the gas space of the digestion vessel. Ignition sources must be avoided (e.g., operate the agitator submerged).
2. The empty digesters are initially blocked from the gas collection system – vent to atmosphere via operationally ready overpressure valves and exhaust lines.
3. The digesters are filled within a short time period with substrate that is as active as possible, until all inlets and outlets (liquid valve closure disks) are sealed with substrate.
5. Once this is done, the fermentation substrate is heated.

Operating Instructions for Initial Startup/Restart of a Biogas System

6. During the re-start/heating of the system, stop feeding.
7. The gas generated during the restarting of the digestion process discharges via the exhaust line (gas overpressure protection) into the open air, and displaces the air that is present in the digester.
8. After testing the gas quality, biogas fills into the gas system and the gas storage. The gas quality is sufficient and there is no explosion hazard if the methane content of the gas is greater than 30% and the oxygen content is < 3%.
9. Once these levels are achieved, the CHP units are turned on. They automatically suction the gas from the gas storage. Sufficient biogas quality can be determined by gas measurement.
10. All safety equipment must be checked for the proper function.

Presenter

Andy Austin – Biosystems Engineer, Scenic View Dairy, LLC

At Scenic View Dairy, Andy's responsibilities include negotiating co-feed agreements to produce higher financial yield, designed and installed waste heat utilization system, and all daily operation and maintenance of seven digesters and 2.4MW of electrical production. Prior to Scenic View Dairy, he worked at Phase 3 Renewables where he assumed various responsibilities including design, engineering, construction & management and identified opportunities to utilize waste energy within existing systems.

Scenic View Dairy, LLC
Brook View Dairy, LLC

"Recycling Resources in a New Way"

Andy Austin

Safety & Anaerobic Digester

- Biogas
- Confined Space Entry
- Maintenance
- Electrical – High Voltage
- Overall Safety
- Weather

Biogas

- Composition: Methane, Carbon Dioxide, and Hydrogen Sulfide – No Oxygen!!!
- Hydrogen Sulfide - lethal composition
- Alarms in genset building
- Biogas sniffers

Confined Space Entry

- Is large enough for an employee to enter fully and perform assigned work.
- Supplied air used
- Harness worn by person entering confined space

Confined Space Continued

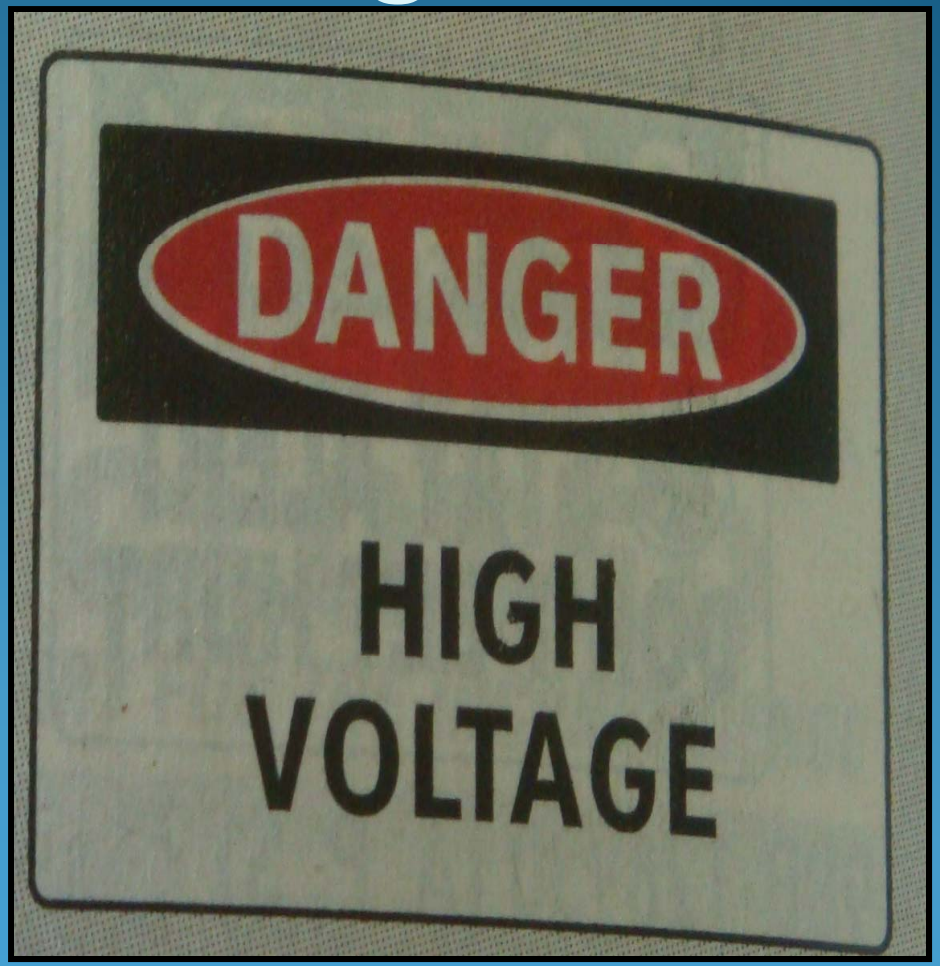
- 2-person system
- Proper ventilation
- Labeled

Inspections/Maintenance

- Daily Biogas Plant Inspections by plant operator
  - Inspect Digester
  - Biogas Piping
  - Gensets
- Maintenance performed both scheduled and non scheduled

Electrical – High Voltage

- Gensets
  - Generating > 480 Volts
  - Breakers w/ lockouts and signage
  - Emergency Stop (E-Stop)
- Property Labeling of High Voltage Sources



Overall Safety

- Safety Meeting w/ Operator
- Make sure proper equipment is available
- Head off any potentially unsafe environments/conditions

Weather Challenges

- Michigan
- Winter
  - Winter - >100” of snow fall
  - Possible Temperatures - > 32˚ F for several days at a time
  - Ice Storms
  - Proper Insulation
- Summer/Spring
  - Thunderstorms - high winds/lighting
  - Power Outages

Summer Storms

Weather Preparations

- Backup generator
- Lighting protection
  - Proper grounding
  - Surge protectors

Questions

www.scenicviewdairy.com

www.brookviewdairy.com

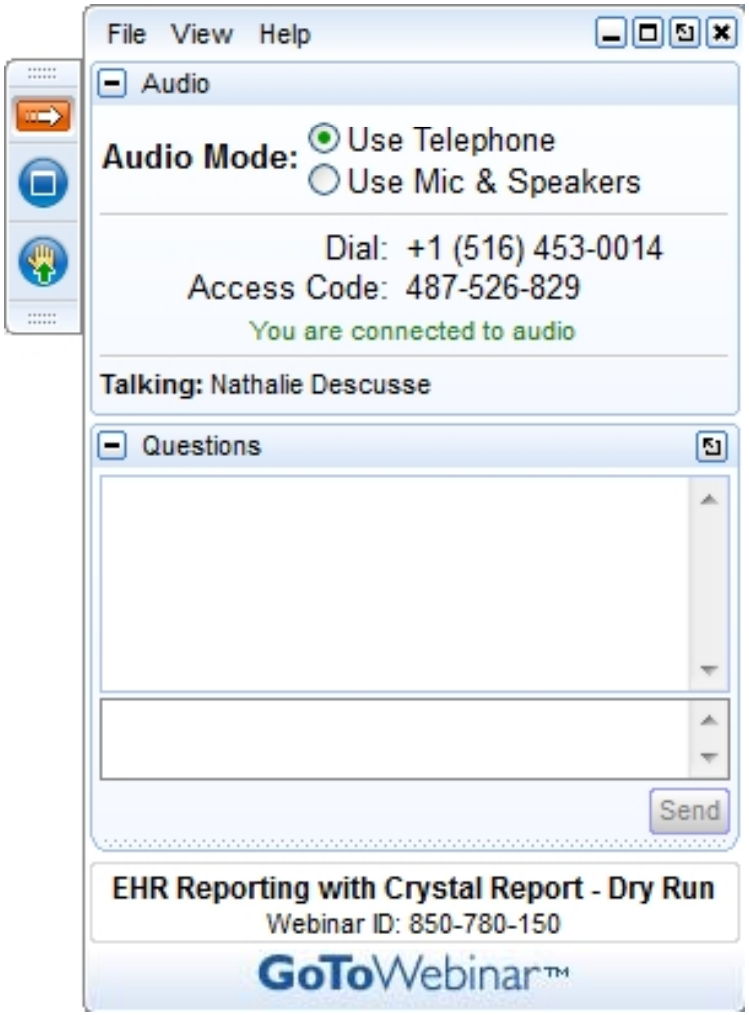
"Recycling Resources in a New Way"

Q&A

Ask questions using the **Questions Panel** on the right side of your screen.

All questions and comments will be recorded and incorporated in the webinar summary report.

Also, please a few moments to answer the survey questions.



Upcoming Events

•This Webinar will be available by Tuesday, September 4

Webinars

• Biogas Financing (sponsored by Caterpillar) – Sept 12, noon – 1 p.m. ET

•Next in Operator Webinar Series:

  •O&M – Sept 27, noon – 1 p.m. ET

•Register at www.americanbiogascouncil.org/about_webinars.asp

ABC Workshops

•Biogas USA West - San Francisco, CA

  •Developing the Biomethane to Vehicle Fuel Market Workshop – October 9

•RETECH - Washington, DC

  • Waste to Energy Workshop - October 16

For more info contact Josh Lieberman: jlieberman@ttcorp.com

More Information

- Don't forget to fill out our survey!
- **Sign up** to receive ABC news on our website, www.americanbiogascouncil.org.
- **Consider Joining ABC**
  --Receive regulatory and policy intelligence
  --Connect with other biogas and anaerobic digestion leaders
  --Support the industry's growth and outreach

Speaker Contact Information

Sara Martin, O'Brien & Gere
315-956-6100, sara.martin@obg.com

Norma McDonald, Organic Waste Systems
513-535-6760, Norma.McDonald@ows.be

Andy Austin, Scenic View Dairy
(616) 502-0959, andy.austin@scenicviewdairy.com

Thank You

Paul Greene, ABC Chairman

Paul.greene@obg.com

(518) 758-2179

Patrick Serfass, ABC Executive Director

pserfass@ttcorp.com

(202) 640-6595